

# EXCESS ENERGY CELL FINAL REPORT

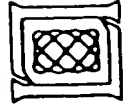
25 APRIL 1995

C. W. HALDEMAN, E. D. SAVOYE, G. W. ISELER, H. R. CLARK

## OUTLINE

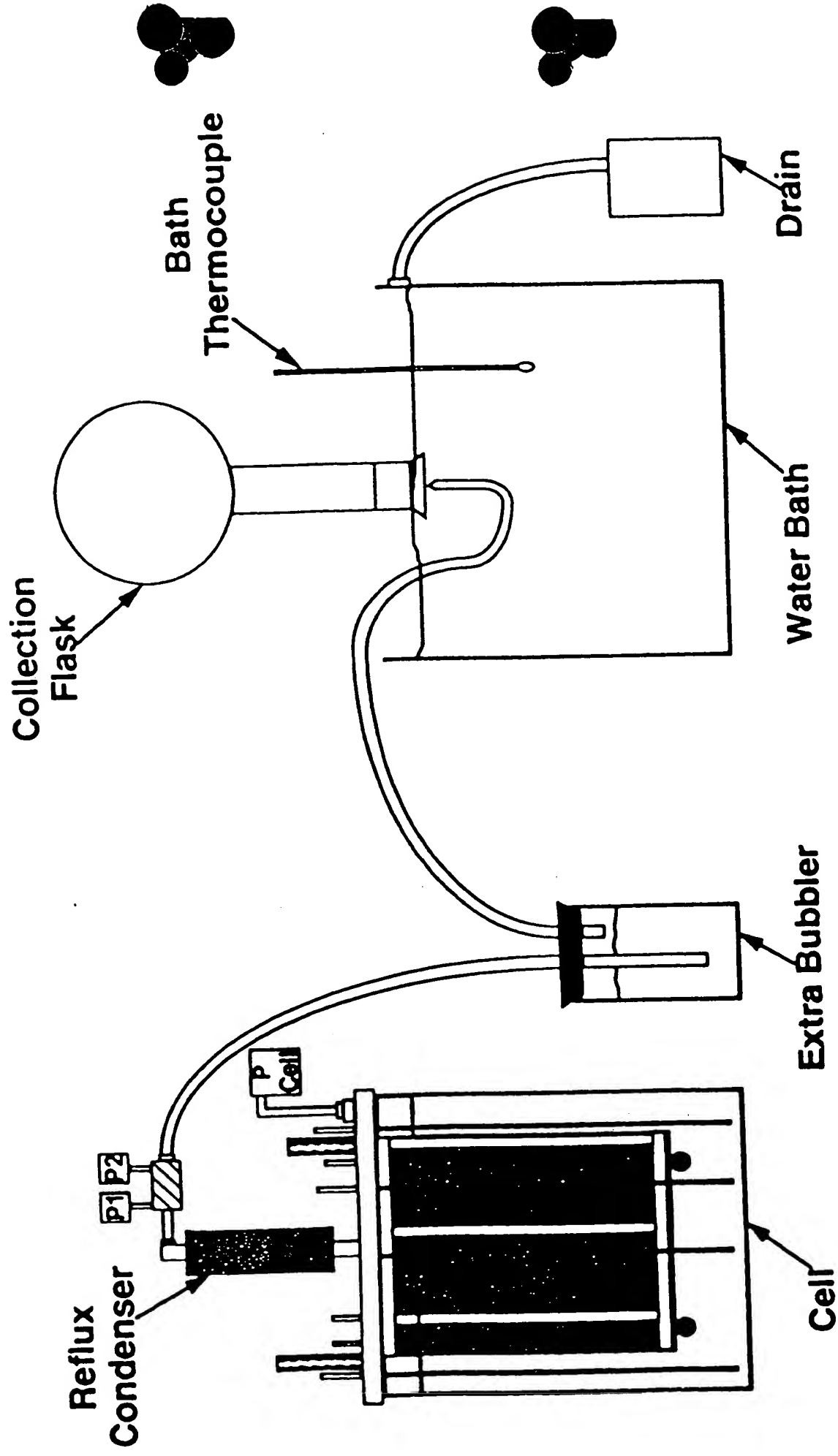
- REVIEW
- CHANGES SINCE LAST REPORT
  - RETURN TO ROOM THERMAL ENVIRONMENT
  - RE-WOUND CELL
  - RESIDUAL GAS ANALYSIS
- ENERGY MEASUREMENTS
- GAS MEASUREMENTS
- CONCLUSIONS

APPENDIX A

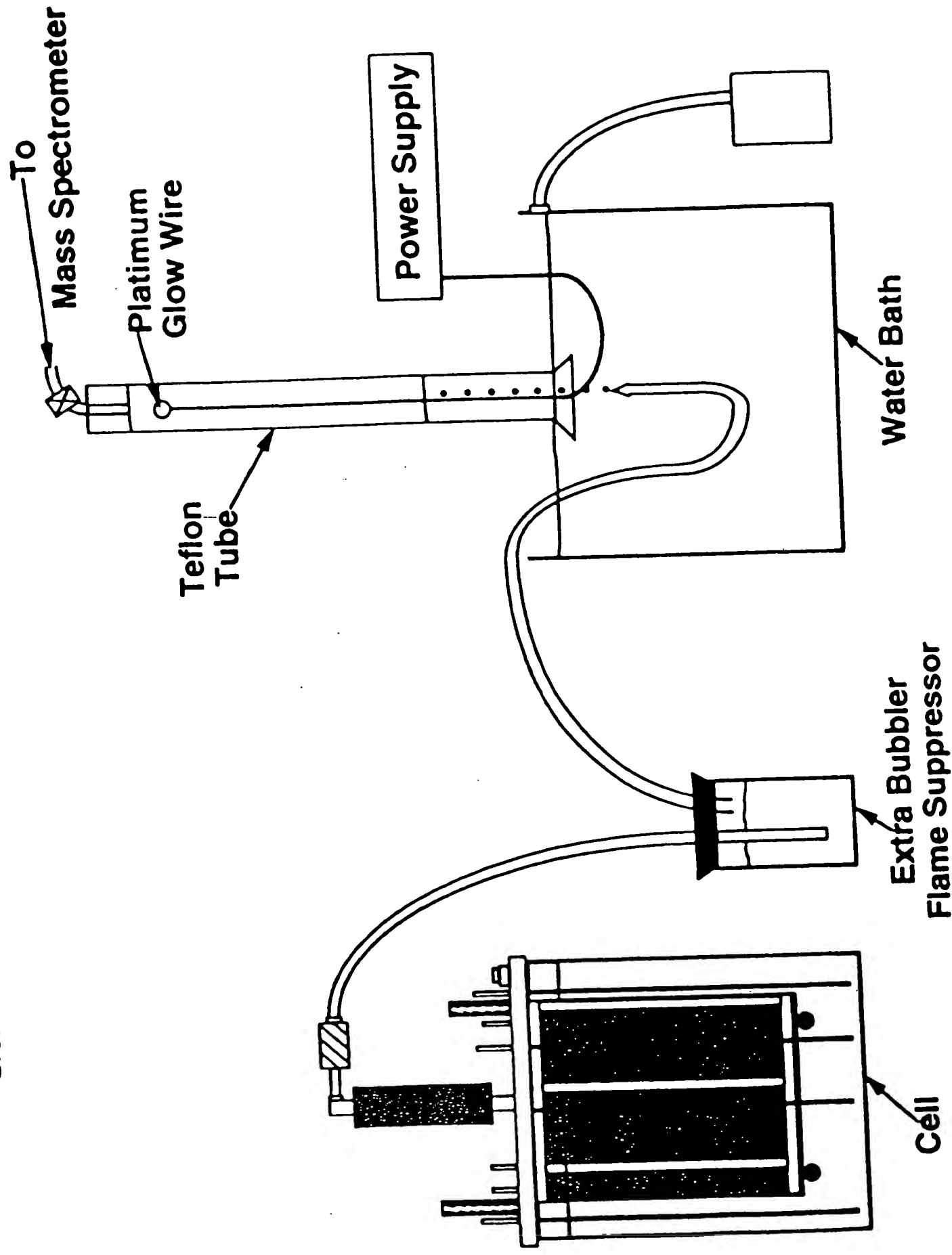


•ec/chuck/4/20

# Sealed Cell Layout



# Gas Collection With Combustion Tube



# SUMMARY OF CELLS ASSEMBLED

<u>CELL #</u>	<u>CATHODE</u>	<u>ANODE</u>	<u>C/A RATIO</u>	<u>RESULTS</u>
1	ANNEALED #41 NICKEL 1.8 lbs 52000 cm <sup>2</sup>	PLATINIZED Ti 100 cm <sup>2</sup>	520: 1	NO EXCESS ENERGY
1A	SAME WIRE HEAT TREATED IN H <sub>2</sub> 770°C	SOFT NICKEL SHEET 3000 cm <sup>2</sup> PLATINIZED Ti 100 cm <sup>2</sup>	17: 1	NO EXCESS ENERGY
2	HARD DRAWN 0.5 mm NICKEL 16,000 cm <sup>2</sup>	SAME	5: 1	5 —→ 10% EXCESS ENERGY
2A	NEW WINDING HARD DRAWN 0.5 cm <sup>2</sup> NICKEL 15,000 cm <sup>2</sup>	PLATINIZED Ti SHEET 3100 cm <sup>2</sup>	5: 1	5 —→ 30% EXCESS ENERGY
3	HARD DRAWN - SCRATCHED #44 NICKEL 190,000 cm <sup>2</sup> (0.002 in.) 0.05 cm dia.	SAME	61: 1	20 —→ 50% EXCESS ENERGY
4	#46 HARD DRAWN SMOOTH NICKEL WIRE 240,000 cm <sup>2</sup>	SAME	75: 1	20 —→ 1400% EXCESS ENERGY 4 x VI INPUT



## OCTOBER 1994 PLANS

1. USE SEALED SYSTEM RECOMBINER / CONDENSER  
TO COLLECT GAS
2. REWIND CELL WITH SMOOTH #46 WIRE
3. USE WET CHEMICAL GAS ANALYZER
4. CONTINUE TO LOOK FOR HIGHER EXCESS ENERGY  
AND CHARACTER OF RESIDUAL GAS



## RE-WOUND CELL

• CATHODE - 4.7 lbs #46 NICKEL WIRE  
Dia. (0.00157 inch) 0.00399 cm

SURFACE AREA 240,000 cm<sup>2</sup>  
CURRENT DENSITY 41  $\mu$  a/cm<sup>2</sup> @ 10a

• ANODE - 5 FOLDED SHEETS Pt PLATED Ti  
15.2 x 20.3 cm

SURFACE AREA 3200 cm<sup>2</sup>  
CURRENT DENSITY 32 ma/cm<sup>2</sup> @ 10a  
75:1 CATHODE: ANODE RATIO

• ELECTROLYTE - 16 l 0.6 M K<sub>2</sub> CO<sub>3</sub>  
IN LAB DI WATER

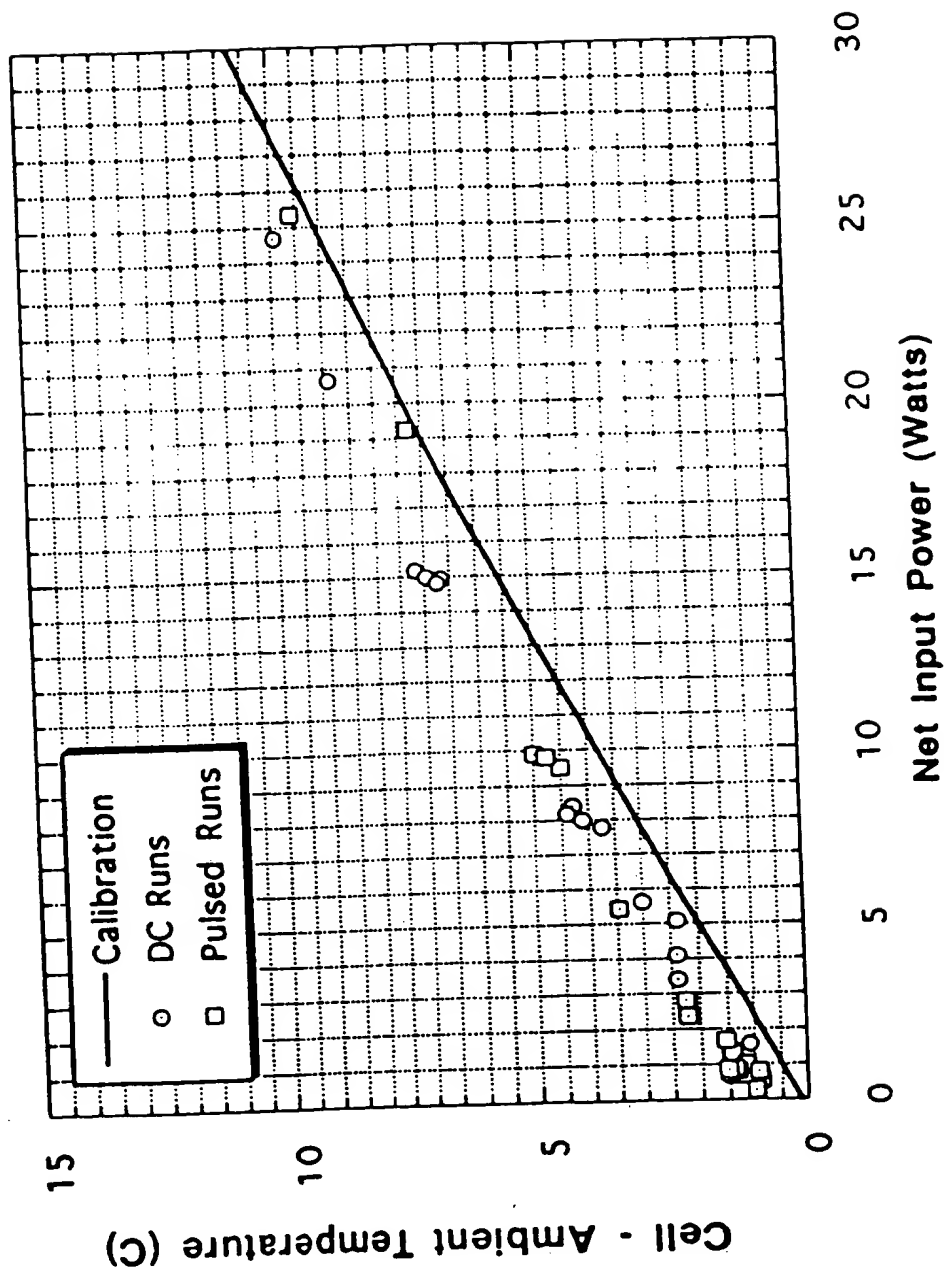
# **GAS FLOW ABSOLUTE MEASUREMENT**

- **DIRECT WATER DISPLACEMENT**
  - 2000  $\pm$  0.5 cc VOLUMETRIC FLASK
- **WATER BATH TEMPERATURE  $\pm$  0.1°C**
- **TIME MEASUREMENT  $\pm$  0.02 sec**
- **BAROMETRIC PRESSURE**
  - NATIONAL WEATHER SERVICE BAROMETER - CORRECTED  
FOR TEMPERATURE AND LATITUDE  $\pm$  0.1 mm
- **MEASURED VOLUME CORRECTED FOR**
  - TEMPERATURE
  - PRESSURE
  - WATER VAPOR CONTENT



gflm/chuck/4/20

# Electrolytic Cell Data Results







[illegible]

4/20/85

File Name Run No.)	V (Volts)	I (Amps)	P (Watts)	Duty Cycle	Freq (Hz)	Peak V (Volts)	Cell (C)	Ambient (C)	$\Delta T$ (C)	H2O Power Correction (watts)	P <sub>in</sub> (Watts)	Output Power (watts)	$\Delta Power$ (watts)	Output P <sub>out</sub> (F=1)	Output P <sub>out</sub> (Watts)
un332/wet lid	3.576	7.032	25.146	100%	0	0	25.718	19.848	5.77	0.0472	13.965	16.049	2.084	114.9%	121.1%
un333/wet lid	3.531	7.010	24.784	100%	0	0	25.156	19.687	5.571	0.0355	13.831	15.486	1.655	112.0%	119.9%
un335b/wet lid	1.950	0.991	1.932	100%	0	0	20.774	20.176	0.598	0.0064	0.464	1.661	1.217	362.0%	365.3%
un328 - This run no. accidentally skipped															
un337/wet lid	2.061	3.162	3.947	20%	6	2.9	21.336	19.754	1.582	0.0096	2.069	4.372	2.303	211.3%	N/A
un338/wet lid	2.220	4.907	7.188	20%	6	3.3	22.352	19.967	2.385	0.0167	4.192	6.583	2.391	157.0%	N/A
un339/wet lid	2.493	7.989	14.130	20%	6	4.0	23.96	19.725	4.235	0.0308	9.416	11.73	2.312	124.6%	N/A
un340/wet lid	2.139	5.819	7.211	10%	6	4.0	21.684	19.615	2.286	0.0099	4.957	6.28	1.303	126.3%	N/A
un341	2.908	11.266	28.364	40%	6	4.0	27.271	19.977	7.294	0.0893	19.221	20.391	1.170	106.1%	N/A
un342	1.799	2.027	1.599	10%	6	2.6	21.325	19.801	1.524	0.0040	0.846	4.213	3.367	498.2%	N/A
un343	2.479	8.110	14.382	20%	6	3.8	24.323	19.827	4.496	0.0317	9.508	12.456	2.950	131.0%	N/A
un344	2.494	6.103	14.370	20%	6	3.6	24.827	20.065	4.762	0.0265	9.796	13.205	3.407	134.8%	N/A
un345	2.906	14.927	34.014	20%	6	6.0	29.659	20.268	9.591	0.0732	25.335	27.037	1.702	106.7%	N/A
un346	1.711	0.839	0.700	20%	6	1.6	21.208	20.198	1.01	0.0023	0.275	2.905	2.530	1019.6%	N/A
Run348	3.233	6.001	25.667	100%	0	0	27.298	20.542	6.756	0.0852	14.825	18.652	4.027	127.2%	155.7%
Run348															0.73

Output P<sub>out</sub>  
(Watts)

4/20/85

File Name Run No.)	Bar. Pressure (Torr)	Bar. Pressure (calibrated)	P <sub>cell</sub> (psig)	P <sub>1</sub> (psig)	P <sub>1</sub> (psia)	P <sub>2</sub> (psig)	P <sub>2</sub> (psia)	P <sub>cell</sub> (psia)	I <sub>1</sub> (C)	Measured Flowrate (cc/min) (fully corr.)	Paradey Efficiency	Data Taken Over Time Period (min)
Run332/veet lid	766.86	761.83	3.7180	3.7100	16.22	3.6900	16.20	0.0200	20.186	73.11	92.75%	3300-3800
Run333/veet lid	776.38	768.88	6.8730	6.8710	20.71	6.8552	20.69	0.0158	19.833	71.51	90.88%	2000-2500
Run335/veet lid	767.86	760.88	1.8190	1.8200	16.31	1.8165	16.31	0.0035	20.443	10.85	97.67%	6600-7200
Run338 This run just a temp run-no data												
Run337/veet lid	780.10	772.25	0.7218	0.7238	15.83	0.8300	15.53	0.0938	20.067	14.01	39.26%	3000-3800
Run338/veet lid	787.89	780.52	0.6398	0.6416	15.32	0.5442	15.22	0.0974	20.235	22.20	40.38%	3200-3500
Run339/veet lid	770.28	762.82	0.0534	0.0548	14.78	0.0428	14.77	0.0120	19.908	34.52	38.64%	2500-2800
Run340/veet lid	785.41	758.14	2.2250	2.2320	16.86	2.2289	16.86	0.0031	19.849	16.51	25.31%	3400-3600
Run341	784.55	767.31	0.4358	0.4415	15.08	0.4193	15.04	0.0222	20.010	66.76	52.86%	1800-2000
Run342	782.89	756.72	0.6187	0.6151	15.20	0.5845	15.17	0.0308	20.066	5.82	24.73%	1900-2000
Run343	788.43	781.04	0.2439	0.2458	14.93	0.2382	14.93	0.0076	20.102	35.80	39.18%	3400-3600
Run344	783.41	756.22	0.8458	0.8492	15.44	0.8410	15.44	0.0072	20.341	33.34	36.70%	2500-2800
Run346	772.93	765.36	0.4704	0.4724	16.24	0.4825	16.22	0.0189	20.466	81.89	36.87%	4100-4250
Run348	776.32	767.88	0.3366	0.3381	16.16	0.3388	16.16	0.0023	20.509	3.19	33.94%	2800-2800
Run348 This run just a temp run-no data												
Run348	786.38	769.07	0.4309	0.4323	16.08	0.4001	16.06	0.0322	20.714	82.84	91.47%	6000-6500



MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
LINCOLN LABORATORY

2 May 1995

TO: Ad Hoc Committee Distribution  
FROM: C. W. Haldeman *CWH*  
SUBJECT: Additional Material

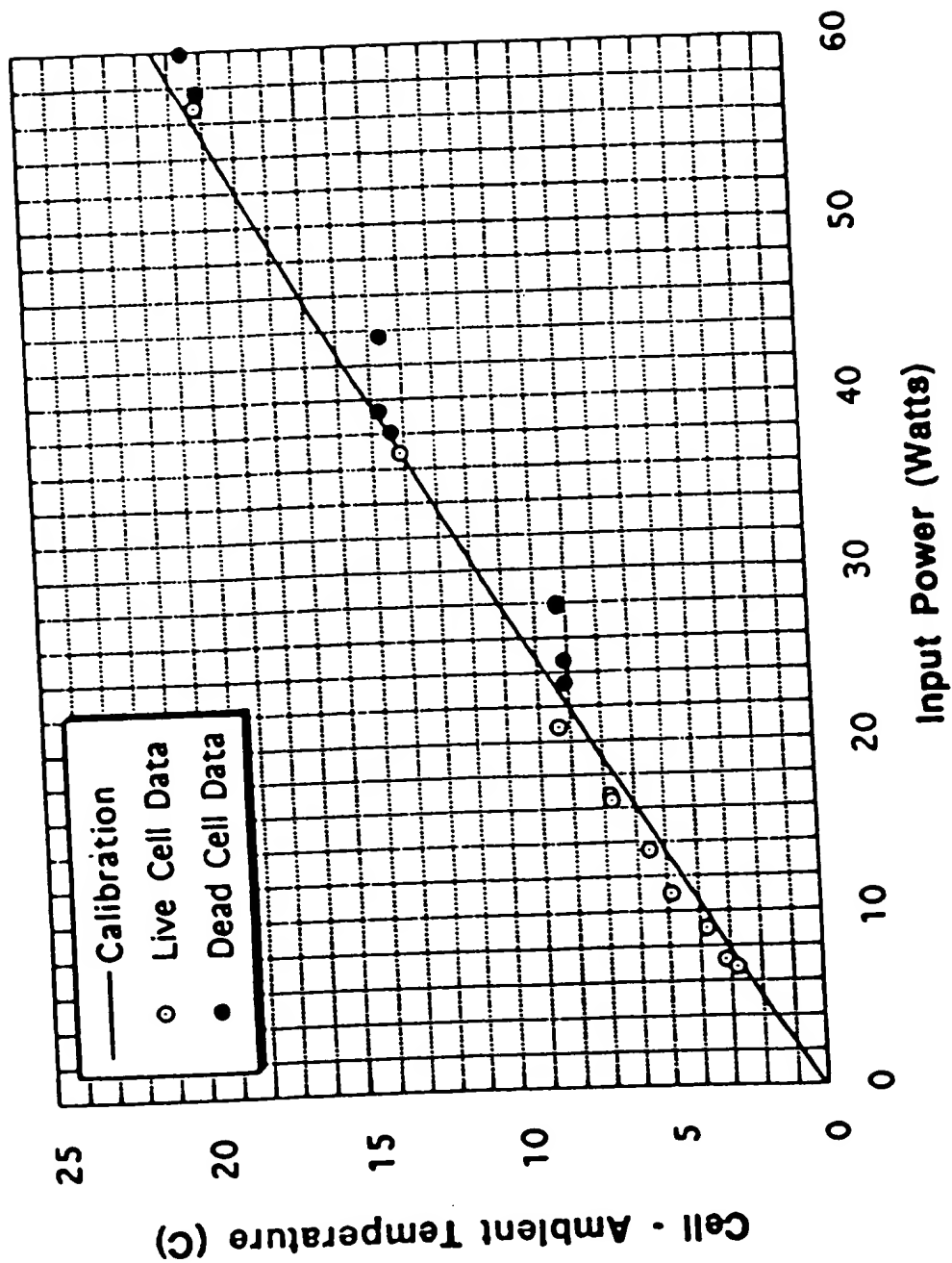
You should have all received my viewgraphs from the 25 April meeting. At that meeting Marv and Ron requested that I replot the data from the new cell (Cell 4) in terms of excess power vs. net input power. This has been done and is attached. The large scatter seems to indicate that the excess power is not a function of net input or at least has a stronger dependence on some variable not controlled. Also requested and included is the old data from Cell 3 which includes data before and after the power failure. The calibration curve is the same for both windings of the cell and includes both calibration and recalibration results.

Since the data now includes both Cell 3 and 4, I replotted the Cell 4 results to avoid confusion. This is the same plot in the presentation which was entitled "Electrolytic Cell Data Results." Please add these figures to the package.

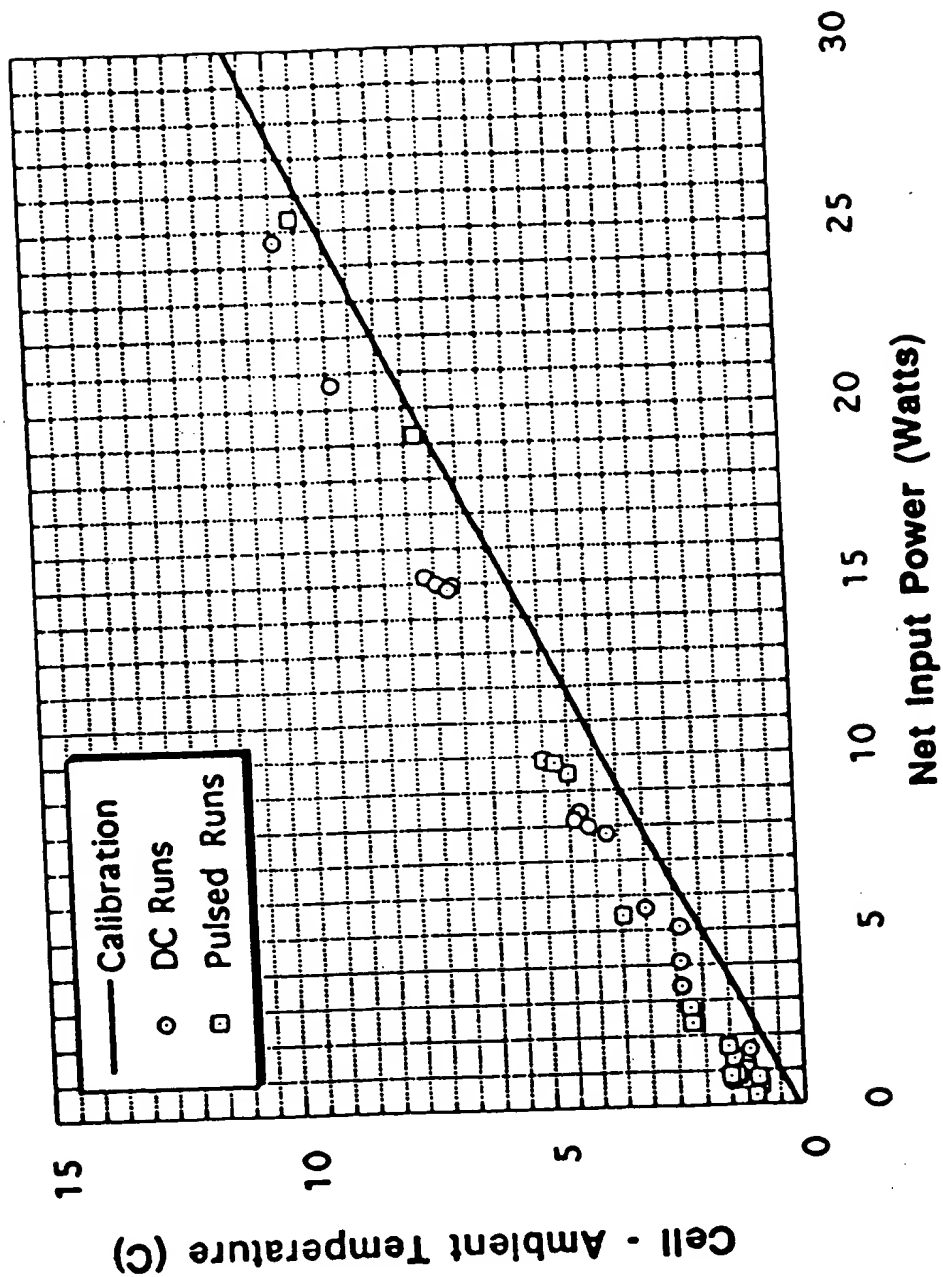
CWH:jf  
Attachments

FOR LABORATORY USE ONLY

# Cell 3 Data Results

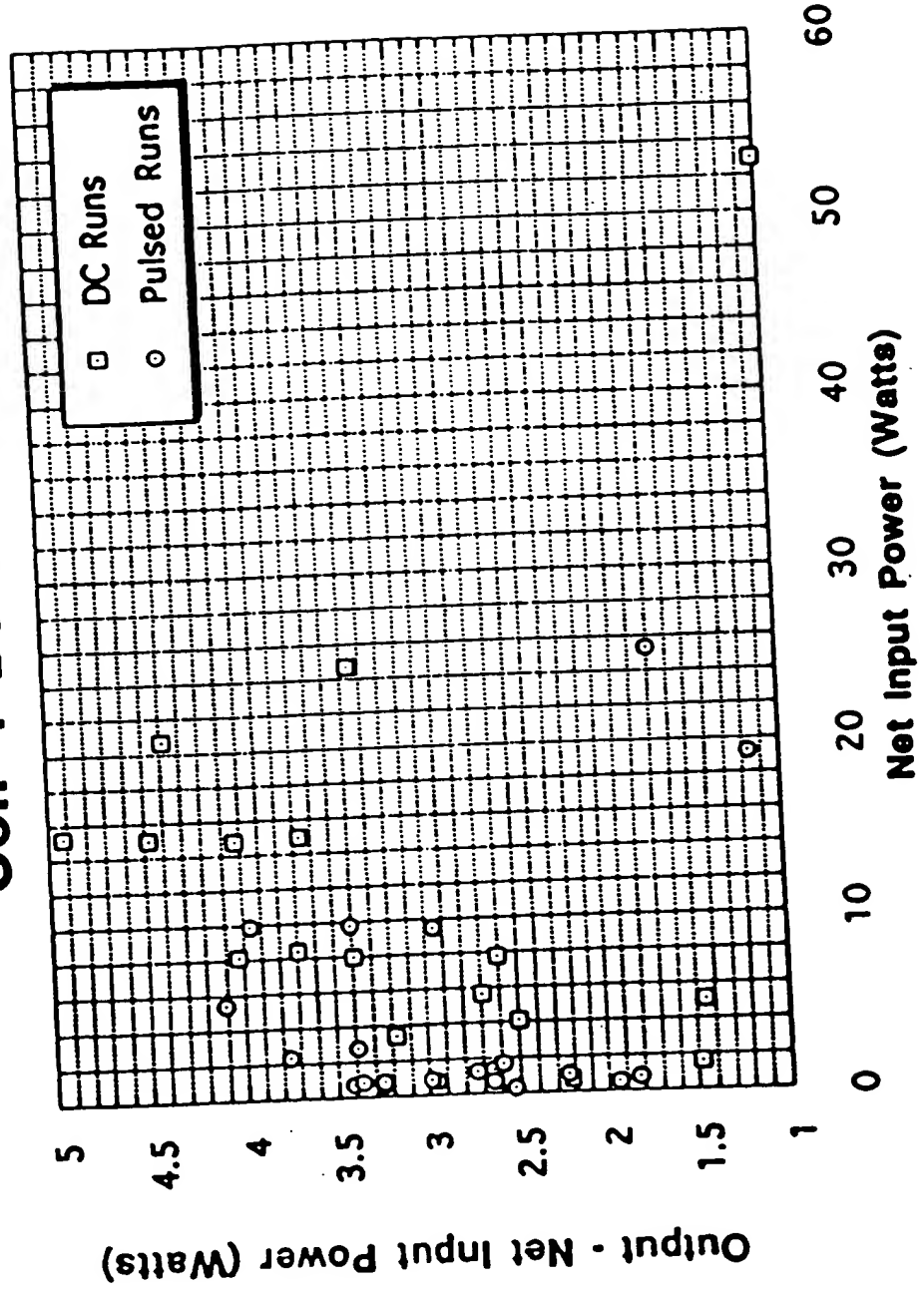


# Cell 4 Data Results





# Cell 4 Data Results

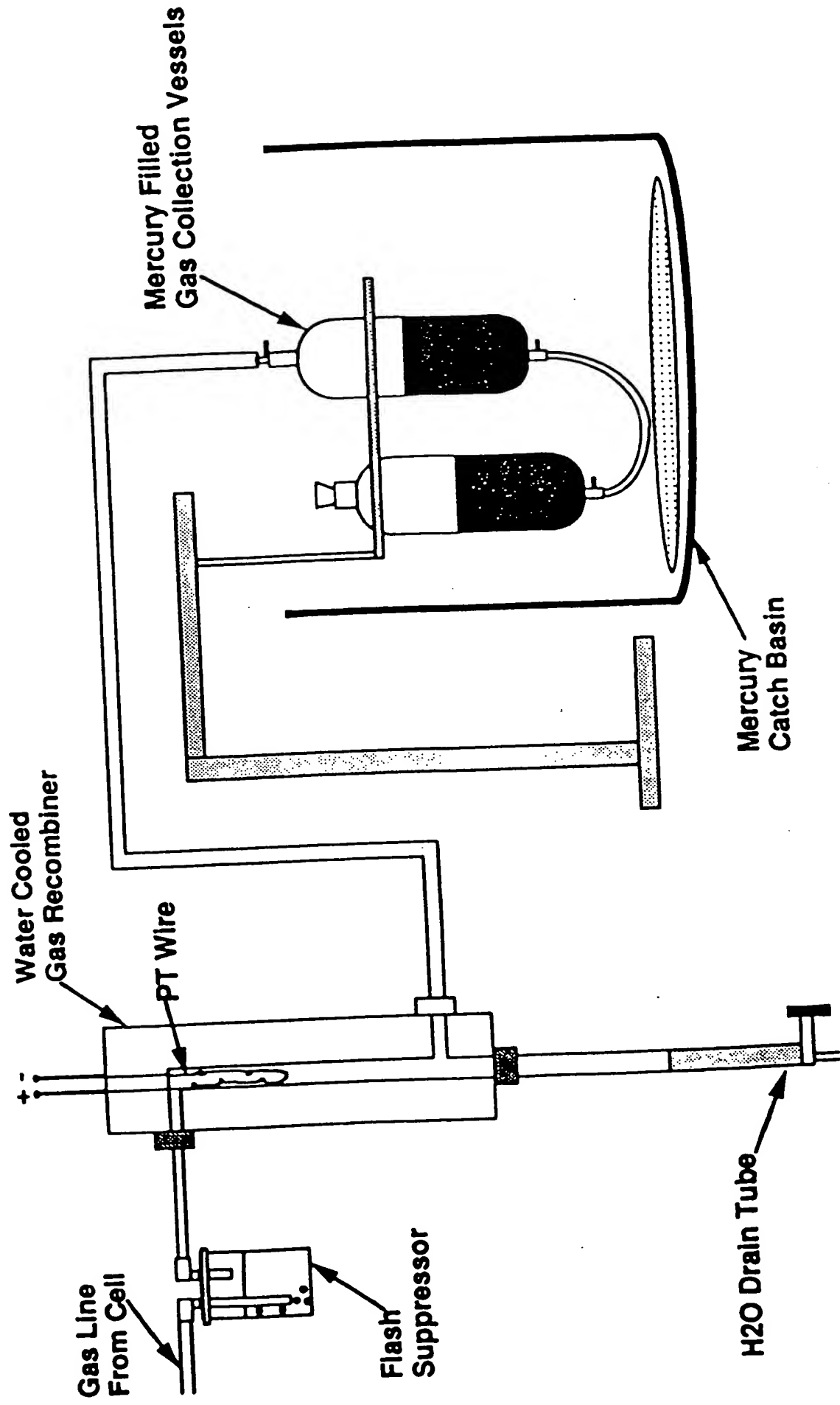


## **GAS MEASUREMENTS**

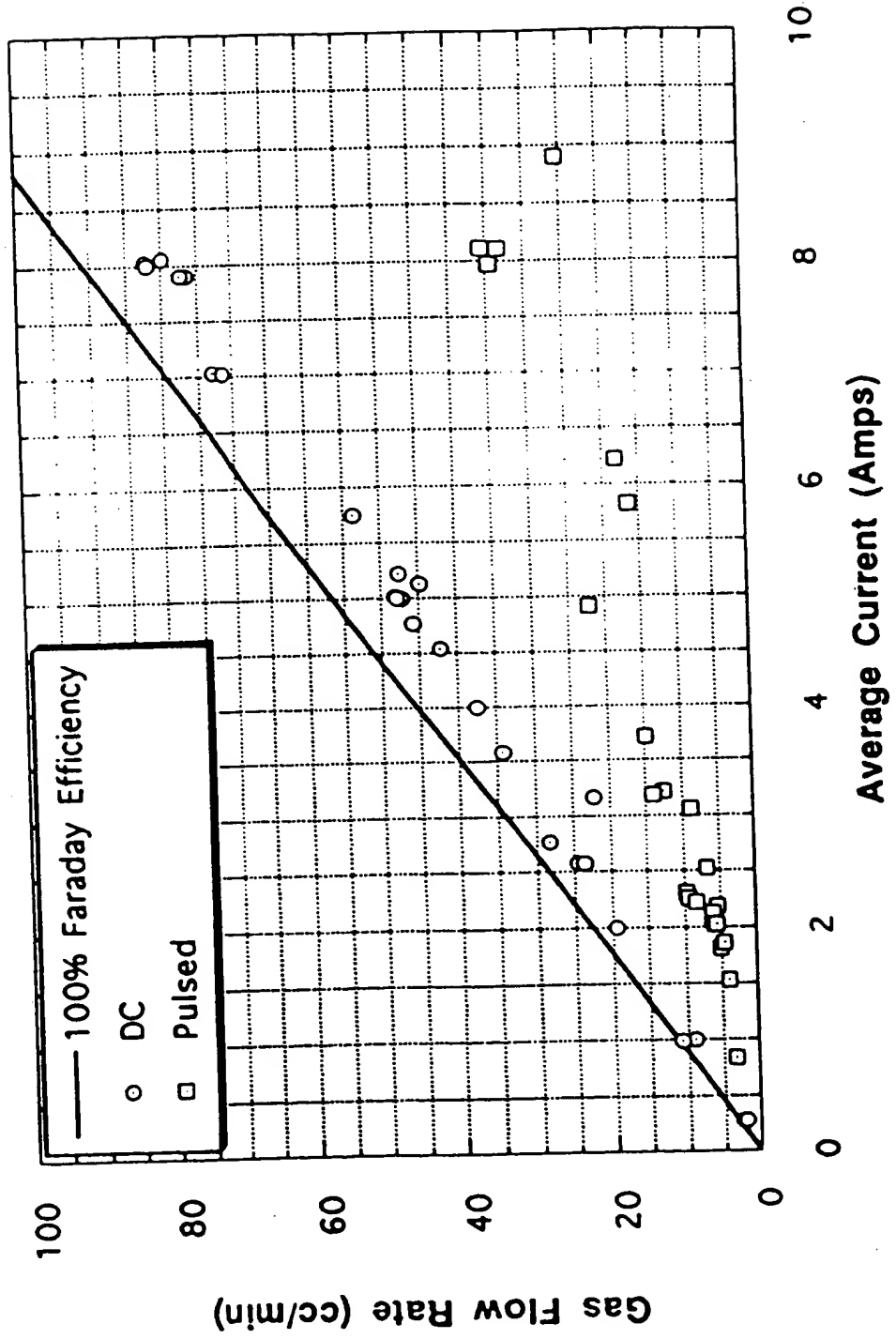
- **CHEMICAL ABSORPTION**
  - BURRELL WET ANALYZER
- **MASS SPECTROMETER**
  - INFICON QUADRAPOLE - 102 VOLT ENERGY
- **CRYO CONDENSATION**



# Electrolytic Cell Current Gas Collection System



# Cell Gas Production



# **GAS WET ANALYSIS** **BURRELL ABSORPTION TUBE ANALYZER**

<b>GAS TESTED FOR</b>	<b>ABSORBENT</b>
$\text{CO}_2$	KOH sol
$\text{O}_2$	$\text{CrCl}_2$ sol
$\text{H}_2$	HOT (300°C) $\text{CuO}$

# WET ANALYSIS RESULTS

## PERCENT

### SAMPLE

CO<sub>2</sub> O<sub>2</sub>

H<sub>2</sub>

RESIDUE

AIR

0

21

0

79

RAW CELL GAS

0

32

67

01

RECOMBINED CELL GAS  
MANY SAMPLES

0

18 → 22

0 → 0.2

BALANCE 78 → 82  
CALLED PROCESSED  
CELL GAS

MASS SPEC ANALYSIS OF PROCESSED CELL GAS SHOWS

N<sub>2</sub>, A, H<sub>2</sub>O

HYDRO-CATALYSIS CLAIMS TO HAVE FOUND 1-2% H<sub>2</sub>



weufchuck/4/20

## RECOMBINER RESULTS

• GAS GENERATION      2 TO 100 cc/minute  
                                 2.8 TO 144 l/day

• RECOMBINED WATER CHECKS OUT GAS MEASUREMENT  
-  $\pm 1\%$

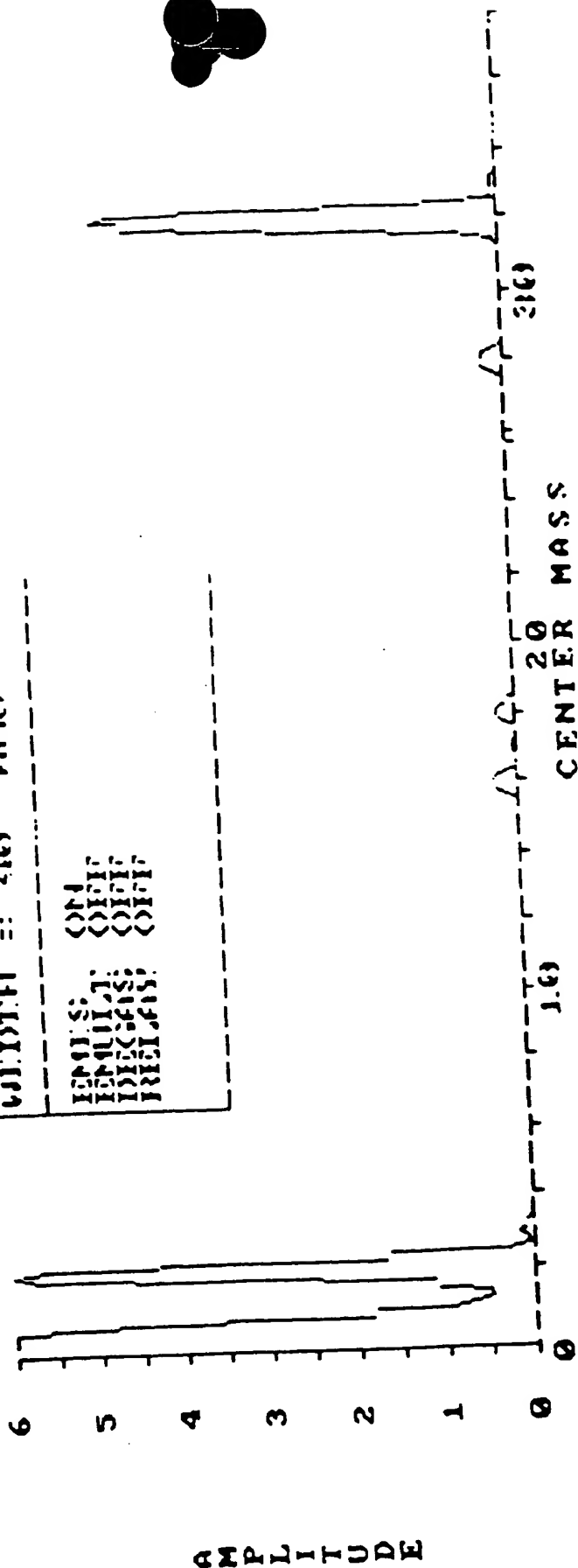
• RESIDUAL GAS FROM RECOMBINER - 50  $\rightarrow$  100 cc/day  
- 1.8% TO 0.1% OF TOTAL GAS FLOW  
- NEARLY 100% CONDENSED OVER LN<sub>2</sub>



rrf/chuck 4/4/20

# "RAW CELL GAS"

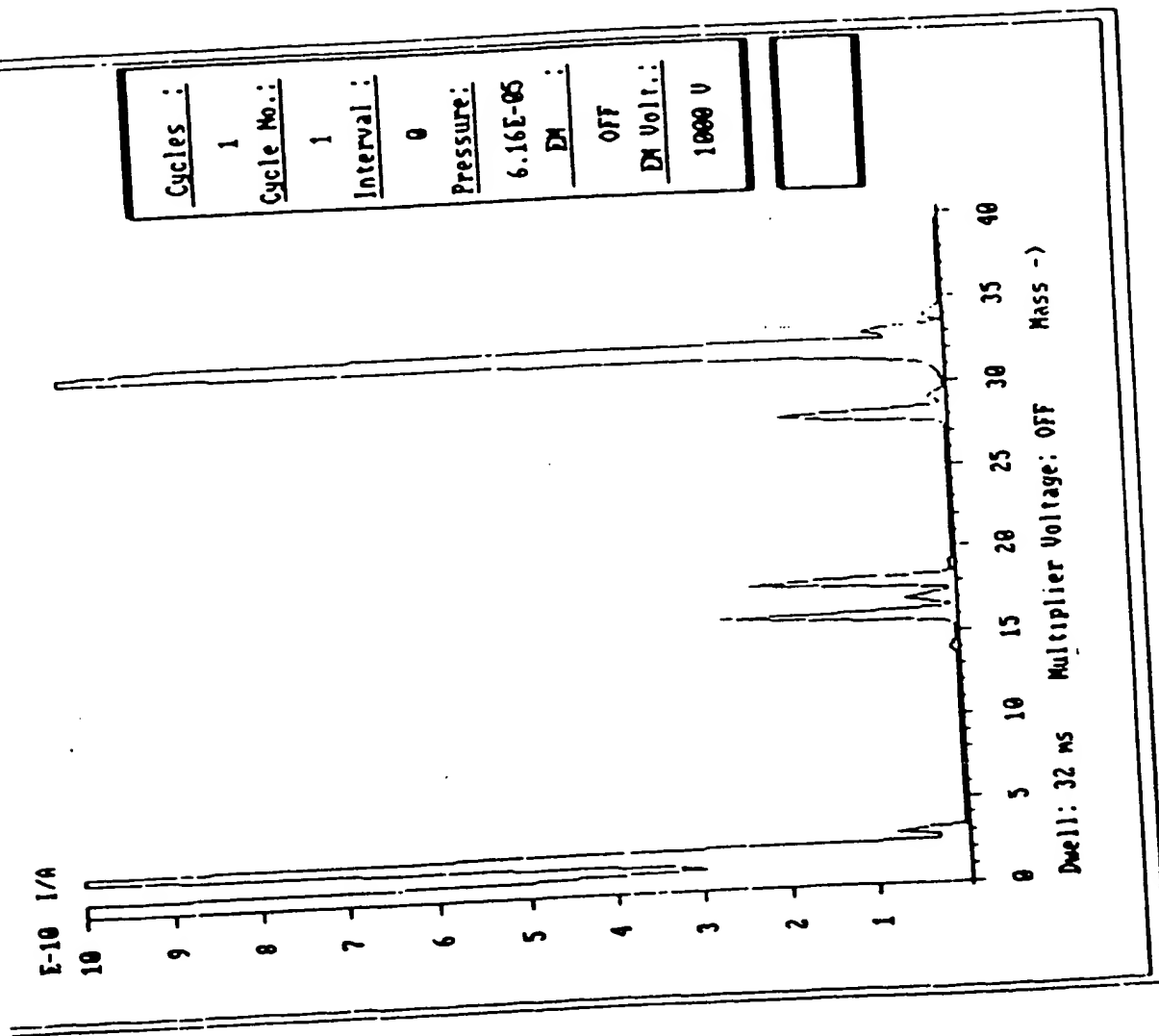
APPROX. MASS	112.030000
1.33: 4162: 414	
APPROX. MASS: 606	1.50505
41. 5013-605	TORR
GRATING = 1.1E-030	61. 61 S
SCANNING = 14	61. 61 S
REACTANT = 1.00000	
REACTANT = 2.00	61.61
REACTANT = 210	61.61
REACTANT = 001	
REACTANT = 001	
REACTANT = 001	
REACTANT = 001	





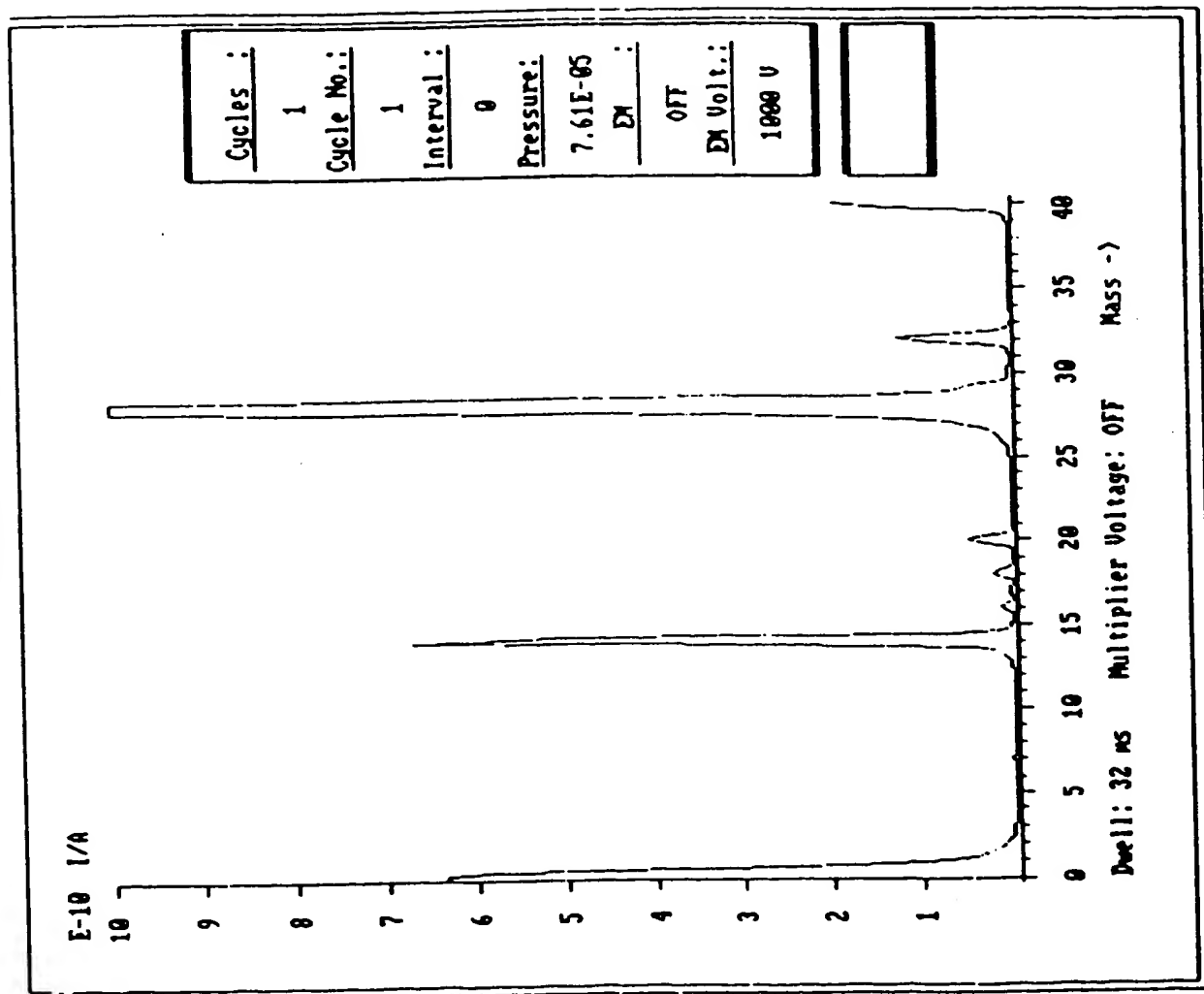
# "RAW CELL GAS"

RUN 334



# "PROCESSED CELL GAS"

## RUNS 332 - 334



# "PROCESSED CELL GAS RUNS 332 - 334

E-10 I/A

10

9

8

7

6

5

4

3

2

1

0

1

2

3

4

5

6

7

8

9

10

Dwell: 32 ms Multiplier Voltage: OFF Mass ->

Cycles :

1

Cycle No.:

1

Interval :

0

Pressure:

7.90E-05

EM :

OFF

EM Volt.:

1000 V

# ISOTOPIC RATIOS - HD/H<sub>2</sub>

SAMPLE	TEST PRESSURE TORR	3/2 RATIO
BOTTLE HYDROGEN	1.3 x 10 <sup>-4</sup>	0.052
LAB DI WATER	9.8 x 10 <sup>-5</sup>	0.035
CELL GAS	9.7 x 10 <sup>-5</sup>	0.025
RECOMBINER WATER	8.9 x 10 <sup>-5</sup>	0.031
CELL ELECTROLYTE	9.9 x 10 <sup>-5</sup>	0.044

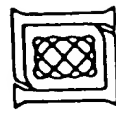


Ir/ychuc W/4/20

## WHAT TO DO NEXT FOR HIGHER ENERGY



- STUDY GAS CELL WHICH HAS MUCH HIGHER ENERGY DENSITY
  - HYDROCATALYSIS WILL PAY - - CRDA ?
- TEST PALLADIUM - SILVER COATED NICKEL WIRE WITH  $D_2O$  SYSTEM ACC CONTINUATION ?
- INVESTIGATE TUBULAR REACTOR USING PALLADIUM - SILVER



## CONCLUSIONS

- EXCESS ENERGY IS PRESENT AT 0.5 TO 5 W LEVEL  
0.5 TO 2.5° ABOVE CALIBRATION

TEMPERATURE CALIBRATIONS  $\pm .02^{\circ}\text{C}$

- GAINS ARE HIGH 5 TO 14 x NET INPUT  
1.5 TO 4 x GROSS VI INPUT

BUT ONLY AT 1-4 W EXCESS

- SOURCE IS NOT DETERMINED

- LOWER STATE HYDROGEN WAS NOT FOUND - WHY ?

- A) NOT THERE
- B) CHEMICALLY MORE REACTIVE THAN REPORTED  
EASILY ABSORBED IN METAL

- ISOTOPIC RATIOS CONSISTENT WITH ELECTROLYTIC CELL  
DECOMPOSITION OF WATER

- CANNOT PROVE OR DISPROVE POSSIBLE EXPLANATIONS  
FOR EXCESS HEAT



c/struct/A20